An Improved Sorting System

Technical Background to the Invention

This application relates to an improved method and apparatus for sorting items, and in particular to an improved method and apparatus for sorting items of mail.

Sorting machines for organizing papers or documents into a predetermined order, based on some input information, are well known. Such machines are essential in the operation of postal delivery services, for example, in which incoming items of mail or 'mailpieces', received in no particular order, are sorted and placed in collecting bins according to the address to which they should be delivered.

Conventional postal sorting machines sort the mailpieces using the postal code of the address to which the mailpiece is to be delivered. Each new mailpiece received at a mail delivery centre is scanned by a visual recognition system in order to retrieve the postal code information of the delivery address. This information is then converted into a machine-readable code which is printed on the mailpiece. If the postal code is missing or, for some reason, cannot be read by the visual recognition system, the mailpiece will be passed to an operator who can manually enter the relevant postal code for printing as a machine-readable code. After the mailpieces have been coded they are sorted into batches corresponding to the delivery area. They are then sent to the mail delivery centre corresponding to the mailpiece address for sorting and delivery.

To sequence sort mail in the order that it would be delivered by a delivery person, most conventional sorting machines require that a single mailpiece be sorted more than once in order for it to arrive at the correct final collecting bin. Such sorting machines are known as multipass sorting machines.

In a first pass, the machine sorts each mailpiece in a batch of mail into collecting bins according only to the first digit or digits of the mailpiece's machine-readable postal code. The mail then has to be collected from the bins and re-input into the sorting machine for a second pass, which then sorts the mailpieces by the next digit or digits of the machine-readable code. Each subsequent pass of the mailpieces through the machine refines the sort until finally they are placed into the correct collecting bins. Some sorting machines require four passes of the mailpieces for sorting to be completed.

A simple example of a multipass sorting process is shown in Figure 1. In this example, the address information of each mailpiece is represented by a three digit number in the same way that addresses are usually represented by a postal code.

The mail is input into the machine in no particular order. The first pass of the machine sorts the mail according to the last digit into three sort bins. The first bin contains all mailpieces with an address that ends with the digit '1', the second sort bin contains all mailpieces with an address that ends with the digit '2' and the third sort bin contains all mailpieces with an address that ends with the digit '3'. The order of the mailpieces within the sort bins is illustrated by-a table in Figure 1.

The mailpieces are then retrieved from the sortbins and re-input for a second pass in the exact order in which they were extracted. In conventional sorting machines, the bottom of each sorting bin is pulled away to release the mail onto a conveyor below for recollection.

This means that the first mailpiece to come out of the machine following the first pass is mailpiece '123', then working up through sort bin 3, mailpieces '213' and '333' followed by the bottom-most mailpiece in sort bin 2 and so on.

The extracted mailpieces are then sorted into bins according to the second digit of the address. As a result, all mailpieces with '1' as the middle digit of the address are placed in bin 1; all mailpieces with '2' as the middle digit of the address are placed in bin 2 and all mailpieces with '3' as the middle digit of the address are placed in bin 3. Within each sorting bin the mailpieces are now in order with respect to the last two digits of the address, as illustrated by table b shown in Figure 1.

Once again, the mailpieces are removed from the sorting bins from the bottom of the leading sorting bin (in this case, bin 3). The first mailpiece to come out of the machine is mailpiece '333' followed by '132', '231', '123', '222' and so on.

Preserving the order in which they were extracted, the mailpieces are then re-input into the machine for a third and final pass in which they are sorted according to the first digit of the address. As a result, the mailpieces are now ordered within each sorting bin with respect to all three digits of the address, as illustrated in table c shown in Figure 1.

The mailpieces may then be extracted from the sorting bins in a convenient order for the mail delivery worker to deliver during his route, that is '333' first so that it is at the bottom of the sorted pile, followed by '321', '312', '231', '222', '213', '132', '123' and finally '111'.

From this example, it can be seen that multipass sorting machines require that between passes the order of the mailpieces is not disrupted; mailpieces must be re-input into the machine for a subsequent pass in the exact order in which they have been output from the preceding pass, otherwise the mailpieces will not be correctly sorted.

Also, to sort a single batch of mailpieces using a multipass sorting machine requires the mail to be input up to four times, and thus takes more time than would be

necessary if the mail could be sorted in a single pass. A known multipass sorting machine is the Siemens SPACS machine which can input or 'singulate' 48,000 mailpieces per hour, but, since the sorting process requires three passes of a mailpiece, can effectively sort only approximately 15,000 mailpieces per hour.

Mailpieces sorted in this way pass along the conveyors and guide wheels of a multipass sorting machine more than once and are therefore subject to increased wear and tear.

Multipass sorting machines are therefore designed to 'singulate' mailpieces at faster and faster speeds to compensate for the much lower sorting speed. 'Singulating' is the term used to describe the separation of a single mailpiece from a stack of mailpieces to be input into the sorting machine. These 'faster' machines tend to be more complex and so more difficult to maintain and adjust. Thus, it is necessary to have technically trained operators present to ensure that the machine is running optimally.

Summary of the Invention

The invention is defined in the appended claims to which reference should now be made.

The preferred system allows items of mail or mailpieces to be sorted exactly to an order which may be specified in a single pass of the sorting machine. Mail can therefore be sorted by the machine quickly and with less wear and tear than known multipass sorting machines.

Mail that is not correctly sorted in the single pass can be reinserted to be sorted again, or can be manually placed into the correct sorting bin.

The preferred sorting machine has the ability to merge mailpieces of different sizes and those which

originate from different sources, such as public collection boxes and mailing houses.

The sorting machine according to the preferred embodiment of the present invention has, instead of a small number of large sort bins, a large number of small bins. In this way, a small number of mailpieces may be allocated to each bin, for example, each bin may be an individual house or person at a business address. The mailpieces are routed to the bin using prior knowledge. This is achieved by communicating data to the machine before any mailpieces are processed through it. Some of this data is derived from machines which scan the mailpiece during the initial phase of the sorting process in present conventional sorting systems. Data can also be derived from the mailpiece producer. The producer may supply relevant data related to the mail they have generated. This data is configured and transmitted electronically ahead of the physical mail. The electronic data may typically include information of destination, addressee, the mailpiece physical dimensions, mailpiece weight and thickness. This data is then used to map the sorting bins of the machine in accordance with the mail about to be processed. As the sorting machine is aware of the number, destination and thickness of each mailpiece, it is possible to allocate a sufficient space in the relevant bin for each mailpiece in the machine. In this way, mail from several sources may be merged as long as the electronic data is written to the machine in advance. As each mailpiece is uniquely identified it is possible to allocate to it a unique position in the machine in advance of its input.

Brief Description of the Drawings

A preferred embodiment of the invention will now be described in more detail and with reference to the drawings in which:

Figure 1 illustrates the order of mailpieces within sorting bins at each stage of an example known multipass sorting operation;

Figure 2 is a schematic illustration of the preferred sorting system according to an embodiment of the invention;

Figure 3 is an illustration of the input means of the preferred sorting machine;

Figure 4 is a simplified side view of the sorting machine;

Figure 5 is an enlarged view of the sorting bins provided on a sorting deck of the sorting machine shown in both 'sorting' position and 'output' position;

Figure 6a shows a three dimensional top view of a preferred diverter plate used in the preferred embodiment of the sorting machine;

Figure 6b shows a three dimensional bottom view of the preferred diverter plate shown in Figure 6a;

Figure 7a shows a top view of an array of the diverter blades shown in Figures 6a and 6b as arranged in the preferred embodiment of the sorting machine;

Figure 7b shows a longitudinal cross-section through the array of diverter blades along line 7-7 in Figure 7a, when all diverter plates are closed;

Figure 7c shows a longitudinal cross-section through the array of diverter blades along line 7-7 in Figure 7a when the central diverter plate is open;

Figure 7d shows the mounting spindle on which the sorting bin guide plates are suspended;

Figure 8a shows a top view of the solenoid arrangement for deflecting the diverter blades of the preferred sorting machine;

Figure 8b shows a side view of the solenoid arrangement of figure 8a; and

Figure 8c shows two views of the front of solenoid arrangement shown in figures 8a and 8b in a resting and activated position.

Detailed Description of the Preferred Embodiment

The preferred embodiment of the invention is a system comprising a sorting machine control system and sorting machine which enables mailpieces to be sorted into a predetermined order in just a single pass or working cycle of the machine. Since mailpieces need to be input into the machine only once, the sorting process is much faster. In addition, the condition of the mail after sorting is likely to be better than that of known multipass sorting machines as only one pass is needed to sort. The novel design of the collecting bins in conjunction with a wide conveyor transport system, allows mailpieces of a wide range of sizes to be handled by the sorting machine.

The preferred embodiment of the single pass sorting machine will now be described in detail with reference to Figures 2 to 8.

Figure 2 is a schematic illustration of a preferred system 100 embodying the invention. The system is divided into four main sections; the first of these represents the collection and cataloguing of mail at local receiving sections and is shown in the top left of the diagram comprising components 102 to 128; the second section, shown next to the first in the top right corner of the diagram and comprising components 104 to 136, represents the generation of items of mail by an external mail producer. The third section, shown below the first two sections comprising components 140 to 144, represents the transmission of the mail and mail information from the local receiving office and external mail producer to a local delivery office. The local delivery office forms the fourth section of the system and comprises components 150 to 152.

The components making up each of these sections will now be described in more detail.

The top left corner section illustrates the reception and indexing of mail in a typical letter sorting office or local mail receiving office. Mail 102 is received from posting points in the local area, taken to the receiving office and input into the local sorting machine 110. Local sorting machine comprises means 112 for receiving mail, means 114 for scanning the mail address information, means 116 for determining the characteristics, such as size and weight, of each piece of mail, means 118 for printing tag or route information on an item of mail, and means 120 for receiving items of mail sorted according to the destination delivery office. In the preferred embodiment, an OCR (Optical Character Recognition) Scanner is used as scanning means 112. 'Tag' information in this context means a unique identifier for that particular item of mail, whereas 'route information' means an identifier for the address to which the mail piece is destined.

Mail 102 received at the input device 112 of the sorting machine 110 is caused, during the sorting process, to pass in turn through each of the different means or parts mentioned above. Each of these parts is controlled by a Machine Control System 126 which additionally receives the addressing information and characteristic information for each item of mail sorted.

Machine Control System 126 is also connected to means 124 for manually entering the address information into the control system if this information cannot be extracted through the scanning means 114. The address information and characteristics of each mail item are transmitted by the control system to Outward Office Computer System 128.

Once sorting of the mail has been completed at the local receiving office, the mail is delivered by transport means 142 to the delivery office illustrated in the bottom-most section of Figure 2. Also, the address information and characteristics of each mailpiece

delivered to that delivery office are transmitted by Outward Office Computer System 128 via Network 140, to the Computer System 150 of the delivery office.

Figure 2 also shows in the top right corner example production of mail by external mail producers. Customer data 104 is entered into the computer system 130 of the mail producer. The computer system 130 is connected to printing machines 132 which it instructs to produce the mail or letter to be sent to customers specified in the customer data 104. The printing machines are also instructed to produce addressed and possibly tag encoded envelopes for each customer letter. The letters and envelopes are passed to means 134 for combining the letters and corresponding envelopes to be sent out as mail. The printing machines and document inserting machine communicate with Outward Customer Communication System 136 to pass on mail information about the mail pieces sent out. This mail is then delivered by transport means 144 to a pre-designated delivery office which serves the addresses of the mail sent out. The address information and characteristics, such as size and weight, of all mail sent out are maintained by Customer Computer System 136, which once the mail has been sent out transmits this information, via Network 140, to the Computer System 150 of the pre-designated delivery office.

The delivery office itself comprises a computer system 150 connected to Network 140 for receiving mail information and for programming sorting machine control system 152 which controls one or more sorting machines 154 (not shown in Figure 2) at the delivery office to sort the mail into the correct order for a mail delivery worker to deliver the mail to the addresses on his route. Route information may be entered onto the delivery office computer system so that the sort order may be determined.

The preferred sorting machine for use with the preferred system will next be described with reference to Figures 3 to 6.

Figure 3 shows a top view of the 'singulaters' used to input mail for sorting into the sorting machine and the bottom deck of the sorting machine 154. A first 'singulater' 210, comprises conveyor belt housing 212 and input conveyor belt 214. Conveyor belt housing 212 has an input end 216 at which mailpieces can be loaded onto input conveyor 214. A person loading the mail onto the conveyor may stand at the input end of the conveyor or behind the long side of the conveyor housing to place mail for input along the length of the conveyor. Situated at the other end of the conveyor housing 212, are barrier 218 and feed conveyor 224, mounted on first and second feed conveyor guide wheels 220 and 222. First guide wheel 220 is situated approximately on the central axis of the input conveyor 214. The direction of travel of feed conveyor 224 is disposed perpendicular to input conveyor 214 and is adjacent to, barrier 218, disposed between first guide wheel 220 and input conveyor housing 212.

The end of the feed conveyor 224 distant to the input conveyor 214 abuts twin feed conveyors 251 and 252 which are disposed adjacent one another and which themselves abut a control portion of main conveyor assembly 255.

The main conveyor assembly 255 is supported on the bottom or input deck 250 of the sorting machine 154, and stretches longitudinally along its length.

A second singulater 230, identical to the first 210, lies behind the first singulater but adjacent to the input deck 250. The second singulater similarly comprises conveyor belt 234 supported by conveyor belt housing 232 with input end 236, barrier 238, and feed conveyor belt 244 mounted on first and second conveyor rollers 240 and 242.

The end of the feed conveyor belt 244 distant to the input conveyor 234 abuts twin feed conveyors 253 and 254 disposed adjacent one another and which together about the end of main conveyor assembly 255.

The main conveyor assembly 255 is a series of conveyor belts mounted on guide wheels 256 which acts to draw mail from the singulater feed conveyors 251, 252 and 253 and 254 along the input deck to a pair of vertical feed conveyors 270 and 280.

Referring to Figure 3, it will be appreciated that mailpieces once they have entered the main conveyor assembly are carried leftwards to vertical feed conveyors 270 and 280 at which point the mailpieces are carried in a direction up and out of the page.

The preferred sorting machine is provided with two singulaters and two arrays of sorting bins, disposed on either side of the machine, and served independently by one of the two vertical feed conveyors 270 or 280. This arrangement allows the sorting machine to be used flexibly, allowing for example, a single singulater and array of sortbins to be allocated to a one sort while the other singulater and array of sort bins are allocated to another sort; alternatively, both singulaters and arrays of sort bins may be allocated to the same sort for faster processing. Possible uses of the machine will be described in more detail later.

In order to direct mail from either singulater to either of the vertical conveyors 270 and 280 and thus to either side of the machine, the main conveyor assembly 255 is provided with two sets of readers 262, 264 and diverters 266 and 268. The readers 262, 264 scan each mailpiece that passes through for the machine readable address information or post code printed on the mailpiece, and notifies the controlling computer system that the mailpiece has been received and read by that particular reader, at that particular time. The controlling computer system may then operate the appropriate diverter 266 or 268 to direct the mail to the allocated side of the machine and the allocated sort bin.

Reference will now be made to Figure 4 which shows the preferred embodiment of the sorting machine 154 in a side view.

It will be seen from Figure 4 that the singulating apparatus shown in a top view in Figure 3 comprises the bottom-most layer 250 of the sorting machine. The conveyor belt assembly 255 and singulaters 210 and 230 shown in Figure 3 are not shown in Figure 4 to avoid complicating the diagram.

The preferred sorting machine shown in Figure 4 comprises input deck 250 and one or more sorting decks 300 comprising input conveyors 302, an output conveyor 304 and an array of collecting or sorting bins 306. Only one sorting deck 300 is shown in Figure 4 for the sake of simplicity, but others could be provided either above or below that shown to provide a larger array of sorting bins.

Mail is passed to the input conveyor of sorting deck 300 by the vertical conveyor assembly 290. This will be understood to comprise vertical feed conveyors 270 and 280 shown in Figure 3. Each of these conveyors comprises a belt 292 borne on rollers 294 and 296, and acts to carry mail from the input deck 250 to the top sorting deck 300. Vertical conveyor assembly 290 may also contain diverters 298 to divert mailpieces to subsequent sorting decks if these are provided.

Referring next to Figures 5 to 8 the structure of the sorting deck will be described in more detail.

Figure 5 shows an enlarged view of the array of collecting bins 306 shown in Figure 4. It will be seen from this figure that the sorting bins 306 comprise a curved plate 308 which hangs suspended from the upper surface of the sorting deck 300 on which input conveyor 302 is mounted. Input conveyors 302 are borne on rollers 303. The upper surface of the sorting deck will be described in more detail later with reference to Figures 6 to 8.

Mailpieces are transported to input conveyors 302 of the sort deck by vertical conveyor assembly 290 pass along the conveyor, from left to right in Figure 5, and are deflected into a pre-designated sort bin 306 by the control system of the sorting machine. The mailpiece falls down the underside of the curved plate 308 or guide in front of it until it comes to rest against output conveyor belt 304 which stops its fall and keeps the mailpiece upright within the sorting bin. The curvature of plate 308 means that any subsequent mailpieces deflected into the bin may slot neatly behind the mailpiece in front of it. This helps to keep the mailpieces in the sorting bin neatly stacked and in the order in which they entered the bin.

The curvature of the curved plate or guide 308 causes the mailpiece to deform and thus partly absorb the energy in it. The region of the guide which meets the leading edge of the mailpiece is provided with a material 309 that acts as a break. The braking action that it provides reduces the speed with which the mailpiece meets the stationary output conveyor and allows the mailpiece to come to rest in a more controlled manner.

The array of sorting bins 310 shown to the right of Figure 5 are identical in structure and shape to the array of sorting bins 306 but are shown in a raised position. The sorting bins may be raised from their rest position by pulling the bottom of each sorting bin guide plate 308 rightwards by means of an actuator connected to pins 312. Raising the sorting bin guide plates 308 allows the mail contained therein to fall out onto the output conveyor belt 304. The output conveyor belt carries the mailpieces towards the output end of the sorting machine, shown on the right in Figure 4, where they may be collected for delivery.

Although only two arrays of sort bins are shown in Figures 4 and 5 it will be appreciated that the sorting machine is modular in design and may comprise one or more

arrays of sorting bins depending on the specified requirements of the machine user. These will need to be given during machine installation. Only two arrays are shown in Figure 4, in modules 1 and 2, to avoid complicating the diagram; the arrays of sorting bins in modules 3, 4 and x have been omitted. 'X' is intended to indicate an arbitrary module meaning that the sorting machine shown in Figure 4 may also be more than five modules in length. The number of sort bins per module may also be determined by the requirements of the user, as for the number of modules and the number of sorting decks per module.

Referring now to Figures 6 to 8, the mechanism for diverting a mailpiece from the input conveyor 302 to a pre-designated sorting bin 306 will next be described.

A mailpiece is deflected into a sorting bin 306 using diverter blades 320 of the type shown in Figures 6a and 6b.

Diverter blade 320 comprises a substantially flat plate 322 which curves a round at one edge to join back on itself forming a loop. Formed integral to the loop and extending slightly beyond the edges of the plate is sleeve 340. The sleeve is hollow and receives a spindle of smaller diameter 360, not shown in figures 6a or 6b, by which the diverter blade is caused to rotate. Plate 322 is provided with a cut away section 330 at the curving edge with a shape that matches the profile of the leading edge 326, 328 of the diverter blade 322.

Briefly referring to Figures 7a and 7b it will be seen that the diverter blades are arranged adjacent to one another in rows, one row behind another. This arrangement of diverter plates forms the top of the sorting deck over which the mailpieces pass and under which the sort bins are disposed. The mailpieces are driven along the sorting deck by means of input conveyors 302 positioned between the diverter blades. The cut away section of one diverter plate receives the leading edge of the diverter blade

plate in the row directly behind it in an interlocking arrangement so that both diverter plates form a horizontal surface for mailpieces to slide over. The interlocking arrangement allows the diverter blade to be long, advantageously providing a gentler deflecting gradient to a mailpiece when the blade is raised, while allowing the sort bins to be placed closer together reducing the overall space requirements.

Referring again to Figures 6a and 6b it will be seen that the leading edge of the preferred diverter blade plate 322 is provided with a flat jutting out portion 326, of narrower width than plate 322, which angles downwards at its end to form a lip or flange 328. Jutting out portion 326 and lip 328 are received in the cut out portion 330 of the preferred diverter blade and make contact with shoulder 332 and ridge 334 respectively. It will be appreciated that other designs of cut out portion and leading edge profile may also be used.

Figure 6b shows the underside 324 of the preferred diverter blade 320. The underside 324 of the plate has a longitudinal spine 336 disposed along its central axis which curves from being narrow where it joins lip 328 to being thick where it joins the curved sleeve at the other end of the plate. This curvature forms a gently sloping deflecting surface 336 which acts to deflect the mailpiece from its horizontal path along the top of the diverter blade in the preceding row downwards into a sorting bin when the diverter blade is raised. Ridge 334 can be seen to be the side of spine 336 opposite to the deflecting surface 338 where the spine passes under the cut out 330 in the plate 322.

Referring now to Figures 7a and 7b, the arrangement and operation of the diverter blade assembly will next be described.

The diverter blade assembly 350 comprises a number of shafts or spindles 360 which are supported on the frame of the sorting deck by pivots 362. Disposed on the spindle

360 are a number of adjacent diverter blade 320 and roller 364 pairs. In the preferred embodiment there are three diverter blades with rollers 264 in between and long rollers 366 at each end.

The spindle passes through the sleeve 340 of the diverter blades and is provided with flats which engage in the diverter blade sleeve so that as the spindle turns the diverter blade is caused to rotate with the spindle. Neither the flats on the spindle or the diverter plate sleeve are visible in the drawings. Rollers 364 and 366 on the other hand are freely mounted on the spindle and rotate as an item of mail passes over them. Input conveyor belts 302 pass over the rows of the diverter assembly 350 in a direction towards the leading edge of the diverter blades at positions above rollers 364,366, that is from the bottom to the top of the assembly shown in figure 7a. Mail is carried in between the input conveyor belts 302 and the substantially flat surface provided by the rollers 364 and 366 and closed diverter blades 320. A side view of the arrangement of closed diverter blades is shown in Figure 7b.

Figure 7b is a cross section through the diverter assembly shown in figure 7a along line 7-7 when all of the diverter plates are closed. The interlocking configuration of the leading edge profile 326 of the diverter blades and the cut out or recess 330 is clearly shown. On the scale shown in this figure, the tops 322 of each diverter blade form a substantially flat surface along which mailpieces may move. In the preferred embodiment of the diverter assembly the position of the spindles 360 and the orientation of the diverter blades 320 is such to introduce a slight convex curvature into the surface. This curvature is sufficient to ensure that the tension of the belt running across the top of the surface rollers 364 and the drive capability of the belting system is sufficient without the need for additional pressure to be applied between the belt and the rollers thus enabling positive

drive between belt and mailpiece. In the preferred embodiment the radius of curvature of the diverter assembly is about 12-16m over an arc length of about 1m.

The curved plates 308 which form the sorting bins are suspended from mounting spindles 390 adjacent the spindle on which the diverter blades and rollers are mounted to form an array of sorting bins 306 as shown in figure 5. The curved plates 308 or mounting spindles are not however shown in figures 7b or 7c.

Figure 7d shows a simple illustration of the mounting spindle 390 on which the curved guide plates 308 of the sort bins are suspended. One of these spindles 390 is mounted on the frame of the sorting deck adjacent to each diverter and roller assembly. The curved plate 308 of the sorting bin hangs vertically down from this spindle to form one edge of a sort bin.

If a mailpiece is to be directed to a sorting bin, the control system of the sorting machine causes the appropriate spindle 360 to rotate, causing a row of diverter blades 320 to be opened and adopt the raised position of the central diverter blade showing in figure 7c.

A mailpiece driven to the right along the top surface of the diverter assembly by the input conveyor 302 encounters the deflecting surface 338 on the underside of the raised diverter blade. The deflecting surface is so shaped to cause the mailpiece to deform and deflect from linear travel into the sort bin below. Once the mailpiece has been deflected into the sort bin the diverter blade is rotated into the closed position.

The mechanism which causes the spindle 360 to rotate and open the diverter blades is shown in Figure 8a, 8b and 8c.

Figure 8a shows the left hand side of the diverter assembly 350 of Figure 2a in an enlarged view.

Spindle or shaft 360 is attached to a rotary solenoid 380 via a coupling 370. Solenoid 380 is secured in place

on the frame of the sorting machine by pins 381. The coupling is shaped to enable the shaft of the roller diverter assembly and the shaft 382 of the rotary solenoid to be coupled by simply inserting each shaft axially within coupling 370 as shown in figure 8b which is side view of the mechanism shown in figure 8a. This is achieved by incorporating flats on each shaft in the required position to enable transmission of torque whilst at the same time maintaining the relative position of one assembly to the other. The opening in the coupling 370 is shaped to accept the flats on the shaft of the roller diverter assembly and the shaft of the rotary solenoid. The coupling is so designed to act as both a means of connecting the roller diverter assembly to the rotary solenoid and as means of reacting the load created by the inertia induced by the operation of the solenoid see figure 8b. The need to support this load becomes more significant in the event of a malfunction at the point of diversion where a mailpiece becomes jammed at the diverter blade. In this event much larger forces need to be catered for as the mailpiece following the jammed piece will be driven into it with the full power of the level transport system. A method of detecting such an event is built into the control system. However, in view of the speed of the machine and the inertia of the transport system it is not possible to stop the machine instantaneously to avoid more than one mailpiece in a jam. A torque arm 372 is an integral part of the coupling moulding which rotates when the rotary solenoid is initiated. At the point where the solenoid comes to rest the arm comes into contact with a rigid pin 384 thus reacting the load. This is shown in the two halves of Figure 8c; in the left half the solenoid is not activated and the spindle is undeflected. Activating the solenoid 380 causes the solenoid shaft 382, coupling 370 and spindle 360 to rotate clockwise to the position shown in the right hand half of the figure. The angle shown here is about 20°.

The operation of the sorting machine according to the preferred embodiment of the present invention will next be described.

A item of mail or mailpiece for delivery is received by the local sorting machine 110 of a mail processing centre and is scanned using known techniques and apparatus, such as OCR Scanner 114, and mail characteristic sensors 116 to determine the address to which the mailpiece should be delivered and physical information about the mailpiece such as size and weight. In particular the thickness of the mailpiece is determined. The address and other information including size information is obtained from scanner 114 and sensor 116 by machine control system 126 and input into computer system 128 where it is given a unique reference number for identification. The reference number is printed onto the mailpiece as a machine-readable code using printer 118. The information describing the mailpiece is then transmitted e.g. via network connection 140 to the computer system of the delivery centre 150 and stored in memory. The mailpiece is then sent to the mail delivery centre dealing with the mail delivery for the area specified on the address of the mailpiece.

Mailpieces from mailing houses and companies that bulk mail-shot are not usually 'posted' in the same way as ordinary mail and so are not necessarily received at a mail receiving centre where the mailpiece details may be input into the system. Instead they are sent directly to each mail delivery centre for delivery to each address in the centre's catchment area. Such mailpieces pose a problem in conventional mail delivery systems since the amount of mail cannot be predicted in advance making it necessary to sort bulk mail and individually directed mail separately.

The preferred system provides a solution to this problem however by providing means to enter data about the mailing house's intended delivery into the system before

any mail is received at a delivery centre. In the system illustrated in figure 2, customer data 104 is first entered into the bulk mail producer's computer system 130. This system then controls the printing of mail to be sent out using printing machine 132 and document inserted 134, and transmits data about the mail such as address, and size and weight of the mailpiece to the bulk mail producer's outward computer system 136. This system then transmits the mail data to the destination delivery office computer system 150 across network 140. The mail is carried to the destination delivery office by conventional means 144.

Thus the delivery office control system 150 knows in advance of sorting the mail exactly what mail it is to receive from local receiving offices and from bulk mail producers and can instruct the sorting machine control system 152 to operate the sorting machine in the most efficient way. This allows both individually addressed mail and bulk mail to be integrated and sorted in a single operation of the machine.

Once an entire batch of mailpieces has been read into the system, the sorting control system 152 calculates the order in which the mailpieces should be arranged according to predetermined route information entered by a user of the system and the address information held in memory for each mailpiece. The route information allows a user to specify the exact order into which mailpieces should be sorted. This means that the order can be made to reflect the route walked by individual postal delivery workers.

The sorting control system 152 then uses the width and thickness information collected for each mailpiece and the addresses of received mail to allocate sorting bins 306 to accommodate the specified sorting order. Unlike conventional sorting machines, in which each sorting bin is used consistently to receive mailpieces with a predetermined postal code or portion of postal code, the

sorting bins of the preferred sorting machine are allocated in response to the route information entered by the user and the size information for each mailpiece. Bins need not be allocated to addresses in the route for which no mailpieces are destined. Similarly, if there is a large amount of mail for a particular address, more than one sorting bin may be allocated to accommodate the mail.

Once the delivery walk order is established, the sorting control system 324 calculates for each position in the delivery walk order, how many mailpieces will be received, and how many sorting bins need to be allocated to accommodate those mailpieces. The result will depend on the thickness of the mailpieces. The mailpieces deemed to fit in the first sorting bin are then allocated to the appropriate bin. Next, the control unit performs a similar calculation for the next position in the walk order. This process continues until all of the mailpieces have been mapped to a destination sorting bin.

The mailpieces are then manually input onto input conveyor 214, and input conveyor 234, to form a stack of mail. The stacks of mailpieces will comprise mail of all different sizes, weights and dimensions, although preferably is of C5 size or smaller. C5 is the maximum size that can typically be accommodated by conventional input singulaters. Mail of size larger than C5 may be sorted by the preferred system but cannot be input into the machine while the singulaters are processing mail of smaller sizes. Mailpieces are input until the conveyor belts are full or there are no more mailpieces to input. The input conveyor belts are then turned on and begin to carry the mail from the conveyor input end 216 and 236 to the ends at which the feed conveyor belt 224 and 244 are situated. A first mailpiece arriving at the feed conveyor belt 224 of singulater 210 will be pushed against the barrier 218 and the feed conveyor belt 224 by the action of the input conveyor belt 214 and the mailpieces in the stack behind it. Feed conveyor belt 222, and all the

conveyors in the sorting machine according to the preferred embodiment of the invention are provided with a surface that has a high coefficient of friction for 'gripping' the surface of a mailpiece. Feed conveyor belts 224 and 244 are additionally provided with small holes. A vacuum pump is used in conjunction with these conveyors to provide a suction which holds the mail to the conveyor. Feed conveyor belt 224 is caused to rotate by rollers 220 and 224 in a direction away from the input conveyor 214 and towards the input deck 250 of the sorting machine. A mailpiece pushed against the surface of the feed conveyor 224, is pulled off the stack of mailpieces by the action of the conveyor belt motion and the suction provided by the vacuum pump, and is input into twin feed conveyors 251 and 252 which support the mailpiece and direct it to conveyor assembly 255 of the input deck 250. This process is called 'singulating'.

The conveyor assembly 255 in conjunction with guide rollers 256 carry the mailpiece from the feed conveyor belt 222 to the vertical feed conveyors 270 and 280. The mailpiece is held vertically by the conveyor assembly 255 while it is being conveyed.

Mailpieces are also singulated at the second singulater 230 and input into the conveyor assembly 255 by feed conveyor belt 244. First and second singulaters 210 and 230 may operate in tandem with each other to interlace the mailpieces received from the two feed conveyors 224 and 244 into a single stream. For this reason it is preferred that mail of sizes larger than C5 are not input at the same time as smaller mail as the larger sizes are difficult to interlace with the smaller mailpieces in an efficient way and because the force required to singulate larger mail places greater strain on the singulater feed conveyors. Mail of sizes larger than C5 can be sorted with the preferred sorting machine and can be merged in with mail of smaller sizes, but it is preferred that the larger mail is input in a separate process. In the preferred

embodiment, a dedicated singulater 314 is provided for this.

Singulater 314 is located adjacent the vertical conveyors 270 and 280. Such a position reduces the path that the larger mail pieces have to travel, which is advantageous because of their greater size and the corresponding greater force that is required to transport them. The mail that is input to the singulater, and from their to the vertical conveyors, is input in a horizontal fashion unlike the mail from the first and second singulater which is input standing on edge and which therefore receives a 90° twist before passing to the vertical conveyor. The shorter distance of travel and the fact that the mail does not requiring much directing or manipulating before it passes to the vertical conveyor means that the wear and tear on the larger mail items is greatly reduced.

Conveyor 314 can singulate items of mail of at least C4 size which are then sorted and merged with the other smaller items from the first and second feed conveyors. This means that promotional material from companies using the mail service to advertise can be easily merged with regular mail.

Each mailpiece passing through conveyor assembly 255 is read by one of the two readers or scanners 262 or 264. First scanner 262 receives mail from singulater 210; second scanner 264 receives mail from singulater 230. First scanner 262 reads the machine readable code printed on the mailpiece at the local receiving office or the bulk mail producer and informs the machine control system 152 of the mailpiece's location within the sorting machine. Like most sorting machines the position of the mailpiece within the machine is tracked by an internal clock. Once the machine control system knows where a mailpiece is it may operate diverters 266 or 268 to direct the mail to the correct side of the machine, and then operate the required diverter plate to direct the mail into the designation

sorting bin at the right time by monitoring how long has passed since the mailpiece was read in. Known sorting machines provide correction methods to ensure that the sorting machine's internal clock is in synchronisation with the expected position of the mailpiece.

The arrays of sorting bins in the preferred machine are disposed on the two sides of the machine. Each side is served by a vertical feed conveyor belt, either 270 or 280, and may be allocated to the same or different sorts. Diverters 266 and 268 divert the mail received from singulaters 210 and 230 respectively to the appropriate side of the machine.

Once a mailpiece has been directed to the appropriate vertical conveyor belt by the machine control system it is carried up onto the sorting deck 300 that contains the destination sorting bin for the mailpiece. The mailpiece may be carried to the top most sorting deck, or deflected to lower sorting decks by diverters 298 controlled by machine control system 152. The mailpiece travels along the sorting deck between diverter blade assembly 350 and input conveyor 302 until the machine control system determines that it has reached the destination sorting bin. The control system activates the solenoid 380 to rotate the spindle 360 and diverter plates 320 just behind the sort bin.

The mailpiece, travelling along the conveyor on a substantially flat aspect with its short edge first, in the case of mail smaller than C5, or with its long side or spine presented first, in the case of mail greater than C5, makes contact with the diverter plate and is directed into the destination sorting bin by means of the sorting bin guide plate 3087.

The control unit then issues a control signal to the solenoid 380 causing the spindle and diverter blades to rotate back to its original position allowing the following mailpieces to flow past unobstructed. This may

be achieved by biasing the spindle with a spring to remain closed.

Once all of the mailpieces in a sorting batch have been directed to the correct destination sorting bins, the control unit may issue a signal to raise the sorting bin guide plates 308, to deposit the sorted mailpieces in the sorted order onto the output conveyor belt 304. The sorted mailpieces can then be output from the machine ready to be delivered. This represents a considerable advantage over conventional sorting machines in which sorted mailpieces are retrieved from the sorting bins by hand.

The operation of the sorting apparatus has been described with reference to just one particular way of allocating the sorting bins. However, other allocation methods are equally possible as will be described next.

In the simplest mode of operation the control unit allocates each sorting bin to an individual position or location in the sequence, this being an individual address on the postal delivery worker's route for example. The sorting bins are allocated in the order that the postal delivery worker encounters the addresses on his route, so that the mailpieces are output from the sorting apparatus after just a single pass in the order in which they are to be delivered. This mode of operation has the drawback that those addresses for which there is no mail have a sorting bin allocated to them. Thus, more sorting bins are required for the sort than will be actually used.

In an improved mode of operation the control unit processes the address information for all the items in a sort and only allocates a sorting bin to those addresses which are to receive mail and leaves out those that are not to receive mail. In this way the number of sorting bins that are required to receive the sorted items may be reduced from that described above.

In a further improvement to the mode of operation the control unit uses the data describing the size of each mailpiece in combination with the address information to

allocate a sufficient number of sorting bins to each position in the sequence, i.e. address, to receive the sorted mailpieces. Thus, there is no danger of a sorting bin becoming full and unable to hold any more mailpieces, as the control unit allocates as many sorting bins as are required before the sort commences.

In another possible of operation of the sorting machine, as described above, the control unit may make use of the size information and the address information to fit the mailpieces into the minimum number of sorting bins. The control unit calculates the order into which the mailpieces are to be sorted and then allocates as many mailpieces to each sorting bin as will fit, preserving the order of the mailpieces across the sorting bins. The sorting bins in this mode of operation are not assigned to a particular position in the sequence and are used to receive as many consecutive mailpieces in the order as will fit. Mailpieces for a number of adjacent addresses may be allocated to the same sorting bin. The viability of this mode of operation is however dependent on the order in which the mail is input into the sorting machine as it is difficult to organise the mailpieces within a sort bin. That is, mailpieces allocated to the same sort bin will be received at that mail bin in the order in which they were input into the machine. In order ~~to~~ use this mode of operation fully, the input order of the mailpieces must be scanned before the sort bins are allocated. Sort bins can then be allocated most efficiently.

The operation of the machine as described above provides a reliable and flexible way of sorting mailpieces. The exact order of the sort can be specified, in contrast to conventional sorting machines which sort by postcode only. Furthermore, mailpieces from any source, including mailing houses, can be integrated into the sort, providing data about the mailpieces is received and input into the system prior to the sort being carried out.

The preferred system also allows rejected mailpieces, that is those which, for some reason, are not successfully deposited into a sorting bin to be output from the system and re-input for sorting. The control unit 'knows' which sorting bin the mailpiece is intended for in advance so that the order in which the mailpieces are received is entirely irrelevant.

Mailpieces that are rejected a number of times may also be manually inserted into the correct sorting bin in the preferred system. The preferred system makes this possible by providing indicator lights which correspond to each bin. In order to determine the intended destination sorting bin for a rejected mailpiece, a machine operator enters the reference number of the mailpiece into the computer system 150 and in response the sorting control unit 152 lights the indicator light corresponding to the intended destination sorting bin so that the machine operator may insert the mailpiece by hand.

The design of the sorting bins and the upper conveyor 302 and guide roller arrangement, which allow mailpieces to be conveyed horizontally means that the sorting machine can manage mailpieces with a wide range of sizes and weights. In particular the machine is able to handle C4 size mail and can easily merge C4 and C5 size mail in one pass.

As described earlier, the sorting machine according to the preferred embodiment has two sides of collecting bins and two singulaters for inputting mail. This allows the sorting machine to be operated in up to four modes; dual singulaters operating separately to produce two streams of mail, each stream of mail going to each side of the machine and comprising mail from only one singulater, dual singulaters operating together to produce only one stream of mail, that stream flowing to both sides of the machine, one singulater acting alone to produce two streams of mail, one for each side of the machine, and one

singulater operating alone to produce just one stream of mail which flows to both sides of the machine.

Dual singulaters in dual stream mode allows the machine to run at full capacity. Infeed conveyors 214 and 234 are loaded with mail and feed each singulater. Each stream of mail from each singulater is directed to one side of the machine, enabling the machine to run as two machines that could handle smaller batches of mail for smaller delivery 'walks'. This facility also allows a considerable amount of machine redundancy due to breakdowns as if, for example, a singulater were to fail the machine may continue processing mail with one stream only. In this mode the singulaters necessarily run at a faster rate than when dual singulaters are used in a single stream mode.

Dual singulaters in single stream mode enables mail to flow to both sides of the machine. In this mode the singulaters will run at a slower rate.

A single singulater in dual stream mode processes mail using one singulater to direct mail to both sides of the machine and may be used if one of the singulaters is to fail. In this mode, the singulater will run at the higher speed.

Finally, a single singulater running a single stream processes mail using one singulater to direct mail to one side of the machine.